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APPLE GROWING IN CALIFORNIA

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General view of young apple orchards in one of the larger districts of California.

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PREFACE

While it is the purpose of this bulletin to cover the field of apple growing in California generally, it is manifestly impossible in a publication of this size to discuss all phases of the industry in any great detail. However, in connection with many of the topics considered, references are given to other available bulletins and it is hoped those who are interested in more complete information regarding any single subject will secure these to supplement that given on the following pages.

GENERAL REVIEW OF THE INDUSTRY

The value of the apple crop in the United States exceeds that of any other fruit. Apples being widely adapted geographically, are grown commercially in all but a few states. Owing to the fact that California produces a greater variety of fruits than any other state and leads in the production of almonds, apricots, peaches, pears, prunes, and walnuts, as well as lemons and oranges, the importance of our apples is usually underestimated. In total production of apples, the state generally ranks fifth or sixth, being exceeded only by Washington, New York, Pennsylvania, Michigan or Ohio. California production for the past eight years is shown in table 1.

TABLE 1
PRODUCTION AND VALUE OF CALIFORNIA APPLES. 1919-1926*

Year	Production in bushels	Farm value per bushel December 1	Total value
1919	8,200,000	\$1.45	\$11,890,000
1920	6,000,000	1.60	9,600,000
1921	6,500,000	1.35	8,775,000
1922	7,850,000	0.90	7,065,000
1923	10,500,000	0.75	7,875,000
1924	8,903,000	1.22	10,862,000
1925	6,016,000	1.15	6,918,000
1926	10,350,000	0.50	5,175,000
Average	8,039,000	\$1.11	\$8,520,000

* Summary of Annual Crop Report 1926 (mimeographed); and California Crop Report 1925. Special Publication No. 63, California State Department of Agriculture, Sacramento, California.

¹ Assistant Pomologist in the Experiment Station.

With the large crop of 1926 in practically all sections, prices received for California apples were extremely low. However, the eight-year averages of total value, when compared with comparable figures of other deciduous fruits during the same period, show the value of California's apple crop to have been approximately three times that of either cherries or shipping plums, three times the almond crop, about one million and a half dollars in excess of the pear crop, and almost as great as that of apricot crop.

In 1920 and 1921 rather extensive new plantings were made in Sonoma, Butte, San Bernardino, Kern, and Inyo counties. During the past five years new plantings have not been so extensive except in Sonoma and Tuolumne counties. The total number of non-bearing trees for the state now shows a slight decline, while the bearing acreage shows a gradual and consistent increase. With the exception of 1923, a heavy crop year, production has been relatively uniform. Yields on the whole are dependable, not being so seriously affected by frosts and drought as are the orchards of the eastern states.

SOIL AND CLIMATIC REQUIREMENTS OF THE APPLE

Although the apple is widely adapted to climatic and soil conditions, commercial apple production in California is limited to certain rather well defined sections, those receiving coastal influences or those in the interior at an altitude of from two to four thousand feet. Early summer varieties may prove fairly successful in certain interior valley locations but often the fruit is prevented from attaining its proper perfection by the excessive heat, low humidity, and strong, drying winds. Winter varieties are entirely unsuited to the above conditions, requiring for their best development moderate summer temperatures with sunny days, a relatively long but slow growing season, and at harvest time sharp, frosty nights.

Apple orchards have been planted on both stiff heavy clay and on extremely sandy soils. Where possible, however, an intermediate type of soil ranging from clay loam to silt or sandy loam should be selected. Such soils are easier to work than those which are heavier, they possess more fertility, and retain more moisture than the sandy soils. Good drainage is essential as the tree roots should be able to strike to a considerable depth without reaching the water table. Shallow soils or those underlaid with hardpan or gravel should be avoided. While good fertility is to be desired, chemical composition of the soil, so long as not strongly alkali, is of secondary importance to its physical properties.

Different varieties of apples often show special suitability to certain types of soil. In the Watsonville section the Yellow Newtown variety does better on the heavier soils than the Yellow Bellflower. The Gravenstein, likewise, is apparently very well adapted to the Gold Ridge fine, sandy loam of the Sebastopol section. With only a few varieties, however, have such soil adaptations been determined with any degree of certainty.

Most apple orchards of California are dependent entirely upon natural rainfall for their water supply. It has generally been thought that where the average annual precipitation amounts to as much as twenty inches, that amount was sufficient for satisfactory tree growth. While this amount may, under favorable soil and climatic conditions produce satisfactory tree growth the first few years, when the trees reach bearing age it is likely to prove inadequate. In some regions where the rainfall is as much as forty inches, irrigation has proved decidedly beneficial. This may be due to an open, porous soil which is not retentive of moisture; also to the fact that all of the rain comes at a season when the trees are dormant.

The actual amount of rain therefore is not of so great importance as the season at which it comes, the location of the section with reference to the coast, and the topography and texture of the soil. Bearing trees need an adequate water supply to produce and bring to proper size a large crop of fruit. In most sections, rains are not expected during the latter part of the growing season, hence irrigation facilities will enable one to apply water to the trees when most needed.

APPLE DISTRICTS

As related to the climatic requirements just mentioned, figure 1 shows the relative importance of apple production in the different counties of the state. The bulk of production centers in the Pajaro Valley in Santa Cruz and Monterey counties, and adjacent to Sebastopol in Sonoma County. Ranking third in importance is the Yucaipa section in San Bernardino County. Others having more than 1000 acres of bearing trees are Riverside, Tulare, Kern, Fresno, Mendocino, Tuolumne, Inyo, and Los Angeles counties. Still others containing smaller acreages have limited sections well suited to apple growing.

Watsonville District.—The Pajaro Valley or Watsonville section is both the oldest and largest section of the state. The plantings consist of Yellow Newtowns approximately 60 per cent, Yellow Bellflowers 30 per cent, and miscellaneous varieties, mostly Pearmaines,

10 per cent. The soils vary from porous sandy loams to clay loams and clays on the terraces and slopes, and from sandy loams to clays to clay-adobes on the valley floors. With an average annual rainfall of twenty inches or more, rather cool temperatures and high humidity, irrigation is not generally practiced. On account of the climatic



Fig. 1.—Outline map of California showing apple acreage by counties.
From California Crop Report, 1925.

conditions, red varieties seldom attain high color. Eliminating a small percentage of the poorest producing orchards, average yields probably are from 400 to 450 packed boxes to the acre, while from the best orchards 800 to 1000 boxes are frequently secured. Crop failures are rare.

The district is well provided with commercial packing houses and cold storage facilities. Several small cooperative selling organizations are in existence, although the major part of the crop is sold to cash buyers, who do their own harvesting and packing. Seasonal contracts are often made for the crop at the time the trees are in blossom.

Although fogs are frequent, fungous diseases are relatively few; apple mildew and the various fungi causing heart rot or wood decay are the most troublesome. Codling moth, aphids, and the leaf roller are the most important insects. Fruit of the Yellow Newtown variety from this section is subject to an internal browning of the flesh which lowers its quality and commercial value. This trouble seems due to climatic factors. Its development in storage can be reduced somewhat by holding the fruit at 36° F rather than at 32° F.

There has been little additional planting of apples in this section during the past ten years, new plantings being mostly pears and apricots.

Sebastopol District.—The Sebastopol district of Sonoma County will, as the non-bearing trees come into production, be very similar in acreage to that of the Pajaro Valley. The orchards are located mainly on the eastern slope of Gold Ridge, a low elevation varying from a narrow strip to seven miles in width and approximately fourteen miles in length. The soil is a very fine, sandy loam well suited to apples. The topography is naturally rolling.

From the standpoint of climate this region, though coastal, partakes somewhat of inland valley conditions. Day temperatures are considerably higher than in the Pajaro Valley, while the rainfall is about one-third greater. Irrigation is not generally practiced but would doubtless be beneficial were water available. Approximately 75 per cent of the acreage is devoted to the Gravenstein variety, for which a wide reputation has been established. Only the best of the total crop is shipped, most of the lower grades and miscellaneous varieties being dried. From 35 to 50 per cent of the total crop is thus utilized annually. The district is well provided with selling organizations, evaporators, and vinegar plants.

Yucaipa-San Bernardino County.—The Yucaipa district of San Bernardino County, located a few miles east of Redlands on the mesa lands at an elevation of 2500 to 3000 feet, comprises some 15,000 acres of tillable land with approximately 5000 acres planted to apples.

In contrast to the older sections above mentioned, Yucaipa plantings are of recent date, the first trees being planted about 1912. The district is therefore just arriving at good commercial production. The soil, for the most part, is a sandy loam with a considerable mixture

of gravel. The climate is characterized by sunny days and cool nights. Frosts and snow are common during the winter season. The annual rainfall of twenty inches is supplemented by irrigation water from wells.

Rome Beauty, Winesap, Delicious, and King David are the chief varieties. The production thus far has been largely sold in Los Angeles and other local markets.

Other parts of the county in which apples are produced are Chino, a well developed area near Ontario, Adelanto and Victorville, high desert districts adjacent to Victorville, and the Oak Glen and Devore mountain sections. While in these sections plantings are limited, excellent fruit can be produced.

Riverside County.—The only commercial apple section of Riverside County is that adjacent to Beaumont. Although smaller, and the orchards more scattering, the district in general is similar to that of Yucaipa. Much of the fruit is sold unpacked in lug boxes on the Los Angeles market, although a considerable percentage of the crop is packed and shipped into Arizona and Texas.

Los Angeles County.—The major part of the acreage in Los Angeles County is located in the vicinity of Downey, with smaller plantings in the Antelope Valley and near Santa Monica. Most of the fruit produced is sold locally or used for by-products.

Inyo County.—Production in Inyo County is confined to the Owens Valley, centering largely in the sections adjacent to Bishop, Manzanar, and Big Pine. This valley, located at an altitude of 3000 to 4500 feet, possesses ideal climatic conditions for producing fruit of high color and good keeping quality. Winesap and Stayman Winesap are leading varieties grown. Lack of transportation facilities, and in some instances sufficient water for irrigation purposes, are the chief disadvantages. Since the purchase of the water rights of this section by the city of Los Angeles, the city is also purchasing and operating a large percentage of the more profitable orchards.

Tuolumne County.—Plantings in Tuolumne County are chiefly around Soulsbyville, Sonora, and Tuolumne, at an altitude of from 1800 to 2500 feet. Winesap, Rome Beauty, and Delicious are the leading varieties. Excellent quality fruit is produced and good prices have been received. Both production and plantings are on the increase.

Tulare County.—The orchards of Tulare County are rather widely distributed over the county from north to south, being located in the foothills along the streams at altitudes of from 1800 to 2500 feet. The general topography is rough with a decomposed granite soil.

Winesap and Stayman Winesap are the leading varieties. Good fruit is produced where the orchards are given the proper care. The crop is sold locally.

Kern County.—Commercial production of apples in Kern County centers near Tehachapi at altitudes ranging between 3000 and 4500 feet. The topography is rolling and the soil is a clay loam. Jonathan, Gano, Arkansas Black, Winesap, Delicious, and Winter Banana are the principal varieties. Most of the crop is disposed of in Los Angeles and Bakersfield. Unfavorable weather conditions, blight, lack of



Fig. 2.—Local markets often prefer their fruit unpacked.
Small lug boxes form an attractive package.

water, and absentee ownership have often reduced the profitableness of the crop. However, over a period of years fair returns have been received.

Fresno County.—Apples are grown in Fresno County on a small scale at Squaw Valley, Dunlap, Miramonte, Pinehurst, and Auberry, foothill and mountain valley portions of the county, at altitudes of from 1700 to 2500 feet. The natural rainfall of from seventeen to twenty-four inches is supplemented in some regions by a small amount of irrigation.

Arkansas Black, Ben Davis, Winesap, Jonathan, Delicious, and Bellflower are the chief varieties produced. Most of the crop is sold locally in the county.

Mendocino County.—Orchards of Mendocino County are somewhat scattered, with the main center of production in the Anderson Valley

about midway between Ukiah and the coast. The orchards are located on cut-over redwood lands and the trees are grown without irrigation.

Baldwin, Rome Beauty, Rhode Island Greening, Gano, King, Ben Davis, and Wagener, as well as a large number of less popular varieties, are successfully grown. Since all fruit produced must be hauled considerable distances over mountain roads to rail transportation, successful marketing of the crop is a most important problem.

Santa Clara County.—The majority of the apple orchards of Santa Clara County are in the bay region from Mountain View to Milpitas, with a less number in the mountain sections. Yellow Newtown, White Pearmain, Smith Cider, Alexander, and White Astrachan, in the order named, are the leading varieties. At the present time planting is not on the increase, the opinion being that the section is better suited to the production of pears.

VARIETIES

CHOICE OF VARIETIES

Of several thousand named varieties of apples twelve or fifteen comprise the bulk of the commercial crop of the United States. In California a large proportion of the crop is limited to Yellow Newtown, Yellow Bellflower, and Gravenstein. This fact, however, does not mean that future plantings should be limited to these three sorts and that other standard varieties, or even new introductions, should not have a place in commercial orchards. In fact some of the lesser grown sorts are under certain conditions proving as profitable as those mentioned. Some thought should therefore be given to the selection of varieties, keeping in mind the following factors.

Adaptability to the Section.—In districts of commercial importance there are usually a number of varieties which are proving more profitable than others. Since these have been determined by trial they should be used as a guide at least in future plantings. As an example, Watsonville under coastal conditions, has specialized on the Yellow Newtown and Yellow Bellflower, both yellow varieties. Interior sections at relatively high altitudes grow neither of these to any extent but rather such colored varieties as Jonathan, Winesap, King David, Rome Beauty, or Delicious. To attempt to produce these varieties under coastal conditions would result in fruit of inferior color. Coastal sections are therefore more restricted in their choice of varieties than foothill or mountain sections. At low altitudes in the valleys where high summer temperatures exist, only fast growing,

early maturing varieties are suggested. In sections where strong winds during the late summer often blow a considerable part of the crop from the trees, an effort should be made to secure early maturing varieties and to avoid those which have a natural tendency to drop.

Variety characteristics.—In addition to this fault of dropping, varieties should be considered with reference to vigor of trees and regularity of crops. Weaker growing varieties, such as Grimes Golden or Wagener; those particularly susceptible to prevalent diseases; and those of irregular bearing habits, as Spitzenburg and Northern Spy, are to be avoided unless past experience has shown that despite the higher cost of production the variety has proven profitable. In some instances quantity is sacrificed for quality, but in commercial orchards this is practical only within certain limits.

Provision for Cross Pollination.—Experiments conducted by the Pomology Division have shown that nearly all varieties of apples under California conditions may be considered practically self-sterile. Jonathan, Delicious, Spitzenburg, and Yellow Newtown are possible exceptions, but even these seem benefited by cross pollination. With the tendency to restrict plantings in commercial orchards to one or two varieties the question of pollination should therefore not be overlooked. With the possible exception of the Yellow Bellflower when crossed with Yellow Newtown pollen under Pajaro Valley conditions, no cases of inter-sterility have been reported, hence in choosing varieties for pollinizers it is necessary to consider only the season of blossoming and in some cases the relative amount of pollen produced. Summer varieties as a rule bloom slightly earlier than fall or winter varieties.

Market Demands.—While home orchards should properly contain varieties of one's personal choice as to quality or flavor, commercial orchards should contain only those of recognized importance. The average retail buyer of apples has a very limited knowledge of varieties and usually confines his purchases to those with which he is familiar. The planting of new or untried varieties in a commercial orchard should therefore be very limited unless they are particularly attractive and possess some outstanding merit which the trade will quickly recognize. The Delicious, a comparatively new variety, quickly gained a reputation on account of its high flavor. It also had the additional advantage of being easily recognized on account of the prominent knobbing around the blossom end. With the exception of Delicious, however, the principal varieties of today have been known and grown commercially from fifty to over one hundred years.

As commercial production also implies the handling and shipping of fruit in relatively large lots, plantings should be limited to a few varieties. The following sorts include the more important commercial varieties of the state and several which are considered valuable for home use. They are listed in their approximate order of ripening, although there will be considerable variation in this respect, depending upon the section in which the fruit is grown.

The illustrations shown are approximately half size for the variety.

DESCRIPTION OF VARIETIES

Yellow Transparent. Origin Russia. An important early variety in the eastern states but little grown in California. Fruit of good size, roundish conic, of attractive greenish to whitish yellow color; thin skin; white, moderately fine-grained, tender flesh; sprightly subacid, and excellent for cooking purposes. Fruit easily bruised. Tree moderately vigorous and subject to blight, but for an early yellow apple under valley conditions this variety is suggested for trial. Season, June 15 to July 15.

Red Astrachan. Origin Russia. A widely known variety recommended for early home use and for local markets. The fruit is of medium size, rather irregular in shape, usually roundish to slightly flattened; skin thin and tender, greenish yellow to striped or a deep red in color covered with a pale, bluish bloom. Flesh white, juicy, crisp and of good quality for both dessert and culinary use. The tree is hardy, vigorous, and an early and regular bearer. The principal defects are, the fruit is not of uniform size, is often small, tends to drop, and is not a good shipper. Season, July.

White Astrachan. Origin Russia. White Astrachan is another variety which has proven well adapted to most parts of the state and is recommended for commercial planting as a summer variety in the Sacramento and San Joaquin valleys. The fruit is of large to very large size, almost round, flattened at each end; skin greenish white with faint streaks of red and covered with white bloom. Flesh white, juicy, crisp, somewhat coarse and acid: primarily a cooking variety. Tree large, vigorous, and productive. One of the best early varieties for local market. Fruit bruises easily and consequently will not ship long distances. Season, July and August.

Gravenstein. Origin probably Germany. The Gravenstein is the most popular and most extensively grown summer apple in California. The fruit is of medium to large size, slightly flattened, broad at the stem end and a little one-sided or angular. Stem short and deeply set in the cavity. Skin a greenish yellow to orange yellow overlaid with broken stripes of light and dark red. The flesh is tender, crisp, highly aromatic and of very good to best quality both as a summer dessert apple and for culinary use. Being the earliest variety grown to any extent commercially and a good shipper it generally brings

relatively good returns. Trees are usually large and vigorous, come into bearing fairly early and produce good crops. The chief defects of the variety are that the fruit drops badly, causing a high percentage of windfalls, and that it seems susceptible to bitter pit. Several pickings are also necessary on account of irregular size and coloring and it is difficult to remove one specimen from a cluster without the others dropping. Recommended both for commercial and home use. Season in Sonoma County, July and August.

Alexander. Origin Russia. A rather widely distributed variety but of limited planting in California. It is one of the more important summer varieties in Santa Clara and Napa counties. The fruit is large, roundish conic to slightly oblate conic in shape, and red or striped in color. Flesh white to slightly yellow, rather coarse but of fair quality for culinary purposes. Cracking of the skin and flesh around the stem and premature dropping are common defects of the variety. The fruit ripens continuously over a period of several weeks. Trees vigorous but not always good bearers. Season, July and August.

McIntosh. Origin Canada. McIntosh is a variety of excellent quality for home use and well adapted to local markets. It is not recommended for commercial planting on account of the tender flesh of the fruit, its susceptibility to apple scab, and the tendency of the apples to drop from the tree prematurely. The fruit is of medium and uniform size; roundish to roundish oblate in shape, regular or faintly ribbed. The skin is thin, smooth and tender, readily separating from the flesh. Color bright red, striped with carmine to dark purplish-red with stripes obscure, overspread with thin lilac bloom. The flesh is very tender, usually snow white color, fine grained, crisp, and tender, very aromatic and of mild subacid to sweet flavor. Quality very good to best. Season, September and October.

Rhode Island Greening. Origin probably Rhode Island. Among the older orchards in the coast counties Rhode Island Greening is frequently found. While an apple of very good quality and well adapted for drying, other varieties are considered more valuable for California. The fruit is of medium to large size, roundish oblate in shape and of dark green to greenish yellow color. Flesh yellow, fine grained, tender, juicy and sprightly subacid. Quality very good. Season, fall and early winter.

Yellow Bellflower. Origin New Jersey. Yellow Bellflower is one of the best known early fall market varieties grown in the state, and in the Pajaro Valley stands second in importance only to the Yellow Newtown. The fruit is of large size, oblong, ribbed and tapering toward the blossom end. The skin is of a lemon color to yellow, marked with prominent dots and with a pink blush on the exposed cheek. Flesh nearly white, tender, juicy and crisp with a subacid flavor. Quality not high but a good fall variety for general use. Although the tree is a strong grower and good producer the fruit varies in size and quality, and necessitates care in handling. Prices received are usually somewhat lower than for later varieties. For these reasons its planting is not being extended. Season, September to November.

Jonathan. Origin New York. The Jonathan is a seedling of the Spitzenburg and in numerous respects not dissimilar to it. It is important among the varieties grown in Riverside, San Bernardino, San Diego, Mendocino, Humboldt, and Sonoma counties. It does well in most all sections where fall and winter apples are grown. Having this wide adaptation, extended planting is not to be encouraged on account of the wide competition from other sources. In shape and color the variety resembles the Spitzenburg but lacks the conspicuous dots on the skin of the former. Flesh light yellow, tender, juicy and sprightly subacid, and of excellent quality for all purposes. A good storage variety for a fall apple. Tree vigorous under good conditions, comes into bearing early and is a good producer. Season, September to January.

King David. Origin Arkansas. A very rich red apple about the size of and somewhat similar to Jonathan. While not of so high dessert quality it is a very attractive market variety and has been planted to a considerable extent for the fall trade. Fruit of medium size, roundish conic, usually of a deep solid red color. Flesh yellow, firm, crisp, moderately tender and of good quality. Season, September to December.

Tompkins King. Origin New York. A variety of secondary commercial importance, grown in mountain sections, and popular in Humboldt and Mendocino counties. The fruit is large, round or globular, angular or ribbed, yellowish, shaded with red and striped and splashed with bright carmine; dots numerous and conspicuous. Flesh yellowish, moderately coarse, rich juicy and tender. Mild subacid flavor and of very good quality. Season, September to October.

Grimes. Origin West Virginia. Grimes, better known as Grimes Golden, is highly esteemed as both a dessert and culinary apple. However, since the fruit requires very careful handling and the trees are inclined to make a weak growth and produce light crops, the variety is grown only to a limited extent. Where it can be produced successfully it is an excellent variety for home use. The fruit is of a clear rich, yellow color; medium to large in size; roundish oblong in shape and often flattened or truncated at the ends. The basin, or depression at the blossom end is abrupt, deep and moderately wide. Skin tough and covered with light russet dots. Flesh yellow, firm, tender and crisp. Flavor mild subacid, rich and aromatic. Quality excellent. Season, fall and early winter.

Winter Banana. Origin Indiana. Where well grown Winter Banana is one of the most beautiful of all varieties. The fruits are large, shapely, of a pale waxen yellow color with a decided pink or sometimes red cheek. It is usually characterized by a distinct suture line on one side extending from the basin to the cavity. Flesh pale yellow, crisp, tender, mild subacid and of a distinct musky fragrance. Quality very good. Fruit bruises extremely easily and not well suited for commercial handling. Grown both in foothill and coastal sections. Season, October to November.

Delicious. Origin Iowa. The Delicious, introduced only thirty years ago, is widely distributed and as a dessert apple is most favorably known. It is found in most of the apple sections of higher altitude and its planting in these section has been extended each year. The fruit has a very characteristic shape, usually decidedly tapering, somewhat irregular and with five very prominent knob-like protrusions at the blossom end. When well grown it is of a dull, dark red color; flesh white, fine grained, very mild acid, aromatic, of delightful flavor and excellent dessert quality. It is a general favorite on the fruit stands and always sells at a high price. The tree is one of the strongest and most vigorous growers, aphid resistant, a late bloomer and good pollinizer. The weaknesses of the variety are that unless well colored it is of poor flavor; it does not cook well, the fruit is inclined to drop and under ordinary temperatures soon becomes mealy. Season, October to December.

White Pearmain. Origin uncertain. An old favorite variety of high quality, adapted primarily for home use and local trade. Rather widely adapted but grown in California primarily in sections having coastal influences where red sorts do not color well. The trees are vigorous and regular bearers. Fruit medium to large size, oblong conic in shape and of pale greenish color, often with a decided blush on the exposed cheek. The surface of the skin is covered with numerous, small, brown dots. Flesh yellowish, tender, crisp, juicy, very mildly subacid and of excellent flavor, somewhat resembling Delicious. Season, October to December.

Wagener. Origin New York. Although a variety of relatively small importance in the state, Wagener is frequently found in Mendocino, Humboldt, Napa, and Sonoma counties. Where conditions are favorable for its growth, it is an excellent fall and early winter variety, but not one of good keeping or shipping quality. The trees are small, upright in habit of growth, and come into bearing early. While only moderately vigorous, good crops are usually produced. The fruit is of medium size, characterized primarily by its flat or oblate shape and by being broadly ribbed from stem to blossom end. The skin is bright, pinkish-red, striped with darker red and often streaked with a thin whitish covering. The flesh is whitish, moderately firm, fine grained, tender, crisp and juicy. Flavor sprightly subacid. Quality very good to excellent. Season, October to December.

Baldwin. Origin Massachusetts. Approximately half the commercial crops of New York and the New England states are of this variety but in this state it is found only in small plantings in the northern coast counties and in elevated regions. In certain of these sections it seems well adapted and grows to a high degree of perfection; in others it does not color as well as is desired. The variety, when well grown, is of large size, roundish conic, deep, bright red in color with a few rather distinct dots. Flesh yellowish-white, crisp, juicy, tender and mildly subacid. Quality very good and adapted for general market, dessert and culinary uses. Season, October to December.

Esopus (Spitzenburg). Origin New York. This variety, usually known simply as Spitzenburg, can scarcely be excelled as a good market variety possessing high quality both when eaten out of hand and when cooked. The fruit is of good size, uniform in shape, varying from oblong to conic; skin smooth, covered with rich red and marked with numerous conspicuous yellowish dots. Flesh yellowish, firm, crisp, tender, juicy and sprightly subacid. One of the most attractive varieties grown. Unfortunately the defects of the variety are such as to make it costly to produce and its planting is generally on the decline. The trees are inclined toward shy and irregular bearing and though fairly healthy are nevertheless subject to apple scab, aphid and, in some sections, to blight. The character of growth is such that long pole-like branches (fig. 7) are formed and it is somewhat difficult to control in pruning. For the above reasons its planting in California is limited. Season, November to February.

Stayman Winesap. Origin Kansas. Stayman Winesap is increasing in popularity and is now successfully grown in the foothills, mountain valleys, and at points of higher altitudes in the interior valleys. In many respects the fruit resembles its parent, the Winesap, differing from it by possessing less color but growing to larger size. The flesh is also more tender, requires careful handling, and does not keep so well in storage. It is characterized as medium to large in size, round conic in shape, with smooth, thick skin covered with dull red and marked with light gray and russet dots. Flesh yellow, fine grained, very tender, crisp, juicy and of pleasant subacid flavor. Dessert quality very good. Among the shortcomings of the variety are that it may fail to color properly in certain sections, tends to drop when mature, requires very careful handling to prevent bruising, and is subject to scald in cold storage. Season, November to December.

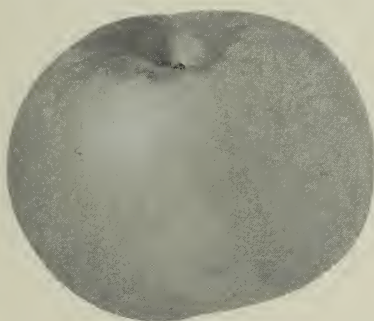
Rome Beauty. Origin Ohio. Rome Beauty is one of the leading commercial apples of the country and has an established reputation in all markets. While not of high dessert quality, the large attractive fruits are especially desired for baking purposes. It handles and ships well and brings good market returns. It is a general favorite in the Yucaipa and Beaumont sections of the state and also in the northern coastal districts. Owing to its late blooming habit it is recommended in sections of higher altitudes, especially where late spring frosts make growing of other varieties precarious. The trees, while only of medium size are, under good conditions, vigorous, come into bearing early and produce uniform crops. Much of the fruit is borne on the ends of branches, which may whip badly in sections of high winds. The variety is also rather subject to the attacks of aphid. Fruit uniformly large, smooth round to round conic; skin thick, smooth, yellow, shaded and striped with bright red to solid red on exposed cheek, sprinkled with conspicuous yellow dots. Stem set in a very broad shallow, usually green cavity. Flesh yellow, firm, crisp and of mild subacid flavor. Quality fair. Season, October to February.



a. Yellow Transparent



b. Red Astrachan



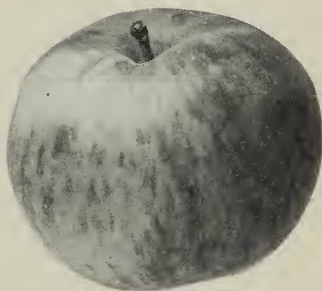
c. White Astrachan



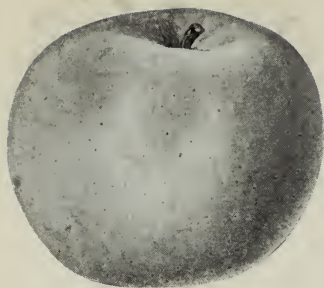
d. Gravenstein



e. Alexander



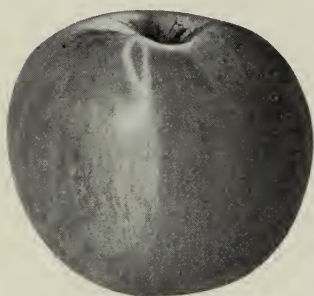
f. McIntosh



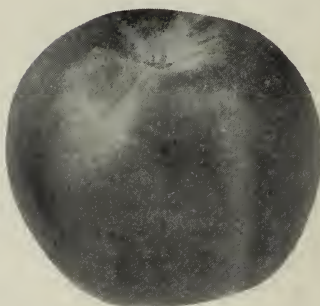
a. Rhode Island Greening



b. Yellow Bellflower



c. Jonathan



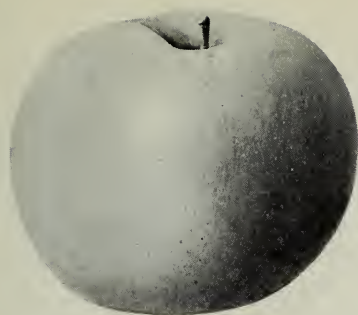
d. King David



e. Tompkins King



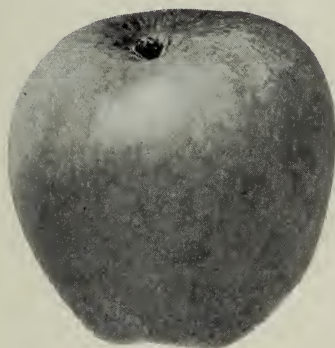
f. Grimes



a. Winter Banana



b. Delicious



c. White Pearmain



d. Wagener



e. Baldwin



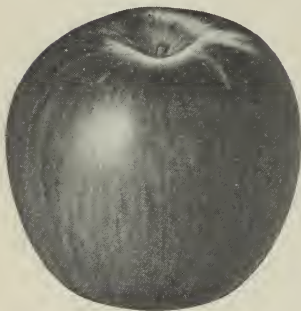
f. Esopus (Spitzenburg)



a. Stayman Winesap



b. Rome Beauty



c. Winesap



d. Gano



e. Yellow Newtown



f. Arkansas Black

Winesap. Origin unknown. The Winesap is one of the oldest and most cosmopolitan sorts and is a general market favorite as a late winter variety. It is grown in most every apple section of the country and in California is adapted to most sections other than those exposed to coastal conditions and those of the hot interior valleys. It grows to a high degree of perfection in the foothills and mountain sections of the state. The trees are vigorous and productive. Old trees have a tendency to overbear and produce small fruit; thinning the crop under such conditions is recommended. Fruit of medium size, roundish to conical; skin tough, smooth, bright to dark red with small scattering dots; flesh yellow, firm, crisp, sprightly subacid. Good to very good quality both for dessert and culinary uses. Season, November to April.

Gano. Origin uncertain, probably Missouri or Tennessee. Gano, often called Black Ben Davis, is a variety similar if not identical to Ben Davis except in the matter of color. While not largely grown in California, the total acreage in different districts of higher altitudes is considerable. The variety is of low dessert quality but excellent for shipping and one of the best keeping sorts. The trees are similar to the widely known Ben Davis, growing rapidly, bearing early, regularly and abundantly. The fruit is medium to large size; roundish conic, regular symmetrical and uniform in size and shape. Skin smooth, waxy, light yellow but mostly overlaid with pinkish-red to a dark purplish-red, more or less obscurely striped; prevailing color red. Dots numerous, small, and inconspicuous. Flesh white to slightly yellow, firm, rather coarse and of mild subacid flavor. Season, November to February or later.

Yellow Newtown. Origin New York. With the Pajaro Valley shipping over a million and a half boxes annually, Yellow Newtown easily ranks as the first commercial winter variety grown in the state. Its commercial production is confined almost entirely to the above mentioned section. The fruit grown under Pajaro Valley climatic conditions is usually marked by a russetting of the skin, which detracts somewhat from the general appearance; the flesh also is susceptible to a browning around the core in storage. The trees of Yellow Newtown are rather slow growing but bear reasonably early and are productive. It is an excellent variety for late winter use. Fruit large, roundish to slightly flat; skin green to yellow, often with brownish red cheek; flesh cream, firm, crisp, juicy and of very good quality. Season, December to May.

Arkansas Black. Origin Arkansas. This variety, often confused with the variety Arkansas or Mammoth Black Twig, is grown in the state only to a limited extent. It is suggested by nurserymen as suitable for interior sections and is of some commercial importance in Butte County. The fruit is roundish and uniform, of a very attractive dark color, the skin being decidedly "waxy" or "oily" to the touch. Flesh a deep cream, very firm, moderately fine grained, crisp and moderately juicy. Of good flavor but not an apple of high quality. The variety ripens in the late fall and keeps well.

Crab Apples.² While of comparatively small commercial importance, crab apples are highly regarded for jelly making and preserving purposes. They are thus grown for home use and supply a limited demand on local markets. The more important varieties are the Whitney, Transcendent, Hyslop, Montreal Beauty, and Large Red Siberian. Of these the first three are perhaps in greatest demand commercially. Red Siberian is reported as being successfully grown in most parts of the state.

PROPAGATION AND ROOTSTOCKS

Cultivated varieties of fruit trees rarely come true to type when propagated from seed. As a consequence seeds are used only to produce nursery seedlings upon which the desired varieties are budded or grafted. To produce nursery stock successfully requires much time and patience besides a certain amount of skill obtained only by experience. Apple growers therefore usually purchase their nursery trees from a nurseryman. There are instances, however, where individual growers wish to produce their own trees. Additional trees are often desired of some particular variation, some unknown variety, or some general favorite no longer commercially propagated. In such cases a knowledge of the general principles of budding and grafting,³ together with a small amount of practice, should enable one to be at least fairly successful.

In collecting seedlings for the propagation of the apple on a small scale, little if any attention need be given to the varieties from which they came, as the seeds are usually collected from cider mills and hence have come from a number of varieties. Most nurserymen have been of the belief that the seed secured from the wild seedlings of France, known as "French Crab," and those from Vermont, known as "Vermont Crab," produced a stronger tree and were better adapted as rootstocks than seedlings of cultivated varieties. However, owing to difficulty in securing such stock in sufficient quantities, seedlings from a large number of commercial varieties have been tried with good success. Notable among these are the Northern Spy and Delicious, both of which are generally regarded as highly immune to woolly aphids.

Unlike the majority of other deciduous fruits which may be grown upon the rootstock of an entirely different fruit, the apple is limited

² For detailed descriptions and illustrations of crab apple varieties see: Beach, S. A., Apples of New York. State Dept. Agr., Albany, N. Y. Descriptions also in, Wickson, E. J., California fruits. Pacific Rural Press, San Francisco, Calif.

³ Fully described and illustrated in, Stahl, J. L., Propagation of deciduous fruits. California Agr. Exp. Sta. Circ. 294:1-24. 1925.

to the apple root. Unions have been made with its near relative, the pear, but these are not successful. Dwarf apple trees, however, may be easily produced by using the Doucin or Paradise apple as a root-stock. The former produces a partially dwarf tree while the latter gives a complete dwarf.

SELECTION AND PURCHASE OF NURSERY STOCK

In order to secure the desired varieties, it is suggested that the nursery order be made out well in advance of the time desired for planting.

California has a large number of nurserymen and good stock can usually be secured from any reliable firm. A first-class nursery tree should be well grown, of the age ordered, and with the wood well matured. The main stem of the tree should be reasonably stocky, the bark clean and smooth, and the top well supplied with good buds or well spaced branches. It should also possess a good union where the bud or the scion was inserted into the stock. If this union has not properly grown together, various fungous troubles are likely to enter at this point and shorten the life of the tree, or it may break off several years after being planted in the orchard.

At the present time the trees which are in greatest demand for planting are those which have grown only one year in the nursery. Owing to the fact that the two-year-old tree receives greater injury to its roots when being transplanted, it is doubtful if it comes into bearing any earlier than the one-year-old tree. The latter also usually possesses a sufficient number of good buds on the stem to form scaffold branches where desired.

Formerly nursery trees were graded only according to height but at present the leading nurserymen also consider the diameter of the main stem and usually grade or classify one-year-old trees into the following groups:

- 4-6 feet high— $\frac{1}{2}$ inch or over in diameter.
- 3-4 feet high— $\frac{3}{8}$ to $\frac{1}{2}$ inch in diameter.
- 2-3 feet high— $\frac{1}{4}$ to $\frac{3}{8}$ inch in diameter.

The price of the trees naturally varies with the size and grade. It is doubtful if the smallest sizes should be purchased when it is possible to secure those which have made a better growth.

Upon receipt of the trees they should be removed from the original package and unless planted immediately, heeled-in at some convenient

place, preferably where they will not be exposed to the afternoon sun. Where trees were ordered from a distance and arrive in a dry condition, the roots may be soaked in water for several hours before heeling-in. Where the branches also appear dry, the entire tree may be put in the soil and covered for a period of several days.

ESTABLISHING THE ORCHARD

PRELIMINARY PLANNING

The profitableness of an apple orchard will depend to a great extent upon careful planning, or the ability of the orchardist to visualize his future orchard, ten or twenty years after planting. Mistakes which are difficult or impossible to correct after the trees are planted can often be foreseen by carefully laying out the proposed orchard on paper, spacing the trees according to scale at the distances decided upon, locating roadways and possible irrigation ditches. Such a map enables one to see how many trees are needed of a given variety, and how they may be spaced to the best advantage. If properly labeled and preserved it may also serve as a ready reference as to the location of any given tree in the orchard.

Of the different systems of planting the square is the most popular and convenient, except perhaps on very rolling land, where contour planting is recommended. The quincunx system—in reality the square method with a tree in the center of each square—is adopted where the orchard is interplanted with temporary or filler trees.

Peaches are sometimes used as filler trees in apple orchards to enable the grower to realize some revenue from the orchard before the permanent trees begin to bear. However, it is believed that the majority of orchardists realize that such a plan often results in the temporary trees remaining too long and causing injury to the permanent trees. Where irrigation facilities are available or there are summer rains, intercropping with small fruits or vegetables is considered more desirable.

Planting the trees too close together has been a general mistake in most of the early orchards, many trees having been set from 20 to 24 feet apart. These are now crowding badly, severe pruning is necessary, and the fruit is difficult to harvest.

The distance of planting apple trees varies somewhat with the variety and soil conditions. The larger and more spreading varieties such as Gravenstein, Jonathan, and Winesap, should be planted at

somewhat greater distances than the upright growing sorts, such as the Red June and Rome Beauty. Deep loam or clay loam soils will produce larger trees than those planted on the lighter soils. The planting distance may also vary to some extent with the severity of pruning. Usual planting distances recommended for the apple on good fertile soils are from 30 to 35 feet.⁴

PREPARATION OF LAND

Proper preparation of the land previous to planting is of great importance in giving the trees a satisfactory start, and their growth the first season often determines their future productivity and profitableness.

Aside from proper plowing and putting the soil in the best physical condition to receive the trees, it may be necessary to first clear the land, level it for irrigation purposes, and give attention to the question of fertility.

The orchards in the larger apple sections of the state are on land which has been cleared and cultivated for a good many years, yet some of the newer plantings are on virgin soil. Much of this land is more or less heavily timbered and considerable work is necessary to prepare it for planting. In some instances, the method followed is only to cut and remove the timber, dig the holes and plant the trees among the stumps. Some of these trees, owing to the very fertile soil, have made good growth, but subsequent plowing and cultivation is difficult and unless the stumps are of a wood which decays rapidly so as to be entirely out of the way after two or three seasons it will eventually prove most economical to dispose of them at once. Oak and redwood stumps are very slow to decay.

While the majority of apple orchards in California are entirely dependent upon natural rainfall for their moisture supply, it is believed many of these would be materially benefited had the land been graded and irrigation facilities provided. Leveling for orchards consists mostly in cutting off the high points and depositing the soil in low places. The grade of the land as a whole is usually changed very little, if any at all. Different systems of irrigation can be used to advantage on the tracts having different slopes.

Deep plowing and thorough preparation of the soil facilitates planting and furnishes the most favorable conditions for rapid root

⁴ For a fuller discussion of planting distances and methods of thinning see: Allen, F. W., Planting and thinning distances for deciduous fruit trees. California Agr. Exp. Sta. Bul. 414:1-29. 1926.

development. Where the land formerly has been devoted to grain crops it is especially desirable to plow a depth several inches deeper than previously practiced in order to break up any "plow sole" which is likely to exist. In some instances subsoiling in the tree rows may be desirable. This should always be done in the fall previous to planting. Except on steep slopes, where washing is likely to occur, the land may also be plowed in the fall. Fall plowed land, left rough, will absorb the maximum amount of moisture during the winter and may be planted earlier in the spring. Thorough discing and harrowing is usually sufficient to put the soil in good friable condition.

New land is usually well supplied with organic matter but that which has been long cultivated or for many years devoted to grain crops is likely to be deficient in this respect. With such soils it is suggested that they receive, the fall previous to planting, an application of barnyard manure, 15 to 20 tons to the acre, or that the land be sown to some green manure crop which can be turned under the following spring. The latter practice is becoming more important as animal manures are becoming more scarce and difficult to secure.

LAYING OUT THE ORCHARD

Properly laying out of an orchard requires considerable care. A mistake made at this time in locating even one or two trees, those from which subsequent measurements are made, may cause a great many others to be out of alignment. Straight rows are not only a source of pride, but are quite desirable from the standpoint of orchard cultivation. The progressive orchardist should, therefore, thoroughly understand the simpler and more satisfactory methods of staking out the trees before attempting the actual field work.⁵

PLANTING

Setting the tree at the proper depth and compacting the soil well around the roots are important considerations in planting. Nursery trees usually form their roots at a depth most congenial for their development and in setting the trees in the orchard they should be planted at approximately the same depth as they stood in the nursery. This depth can generally be determined without difficulty from the appearance of the tree trunk.

⁵ Wickson, E. J., California fruits. 10th ed., pp. 85-92. Pacific Rural Press, San Francisco. 1926.

In order to avoid air pockets, well pulverized soil should be placed next to the tree roots and tramped thoroughly as it is thrown in. All injured roots had best be removed before setting. In order to facilitate planting, the remainder may be shortened back to six or eight inches. Cutting back is considered preferable to bending out of their natural position. Small, fibrous roots, usually dead before the tree is set, may likewise be removed as these make it more difficult to place the soil in firm contact with the larger roots.

As it requires some time for the newly transplanted tree to become established and as it is desirable that new root growth precede that of the branches, trees may profitably be planted as early in the season as mature nursery stock can be secured and the soil can be put in good condition. Where conditions are favorable for planting in late November and in December, trees set at this time should have considerable advantage over those not planted until March or April. However, at some of the higher altitudes it often may be necessary to delay planting until relatively late. Under such circumstances an effort should be made to hold the trees as nearly dormant as possible in order that the buds may not push and utilize all of the stored food previous to the growth of the roots.

As a large portion of the feeding roots are cut in digging from the nursery, the top of the tree should be reduced to a corresponding degree. At the time of planting, therefore, the main stem is usually cut back to a height desired for the scaffold branches. Immediately after planting it is recommended that the trees be protected from sunburn, and incidentally from borers, by coating the entire stem with whitewash.

CULTURE

ORCHARD CULTIVATION

Young trees should be encouraged to make rapid growth and for this reason, if for no other, should receive good cultivation. In young orchards plowing is usually recommended once each season. In older orchards discing or chiseling is being substituted to some extent for plowing.

The exact time of plowing will depend primarily upon the condition of the soil, the amount and season of rainfall, and the growth of weeds, or cover crop on the land. Many soils must be worked at just the right time, as plowing either too wet or too dry results in a hard lumpy soil often for the remainder of the season. In young

orchards, the plow may be run reasonably close to the trees without injury. Rather deep plowing the first two or three years will also encourage deeper rooting. With the older trees, however, where previous plowing has been shallow, some damage may be done to the roots by close or deep plowing. In order to prevent a series of permanent furrows and ridges between the tree rows, the direction of turning the furrows should be reversed each year. After spring plowing, the soil, while the surface is still moist, should be pulverized with a disc, spike-tooth harrow, or both. Spring-tooth harrows are also used, being especially satisfactory in gravelly soils (fig. 3).



Fig. 3.—In light soils the spring tooth harrow is an excellent orchard tool.

With the soil put in good tilth at the beginning of each growing season the frequency of subsequent cultivations will depend primarily upon weed growth and the frequency of irrigations. It seems to have been shown that cultivation for the conservation of moisture by evaporation is unnecessary so long as the soil is kept free from weeds or other vegetable growth.⁶ Frequent and continuous cultivation, therefore, after the weeds are killed, or the crust or cracks broken up, is both expensive and useless.

While the majority of bearing orchards are maintained under a system of clean culture or of cultivation and cover crops, there are some, primarily in the foothill and mountain sections, which receive

⁶ Veihmeyer, F. J., Some factors affecting the irrigation requirements of deciduous orchard. California Agr. Exp. Sta. Hilgardia 2:125-290. 1927.

little cultivation. Weeds and grass are allowed to grow throughout the summer months, this vegetation being turned under the following spring. While this system of soil management gives the orchard a neglected appearance, it may be justifiable where irrigation water is plentiful and cheap.

Such a system of management is advantageous in that it reduces an important item of orchard cost, it increases the organic matter and moisture holding capacity of the soil, and practically eliminates washing of steep slopes.

FERTILIZATION

Although many orchards have been grown with little thought given to soil fertility, its importance as related to tree growth and yields is now generally receiving greater attention. While in some instances apple orchards are on new land which may contain a relatively high nitrogen content and be well supplied in mineral elements, the majority of trees in the larger producing sections are on land which for reasons previously mentioned are likely to be low in available nitrogen and organic matter.

Animal Manures.—Organic matter is derived from animal manures and from the decay of plants. Owing to the fact that manures add nitrogen and at the same time improve the physical condition of the soil they have long been recommended. At the present time, however, their scarcity limits their use to a comparatively few who are situated near large sources of supply. When the cost is not prohibitive, applications of ordinary barnyard manure may be made at the rate of six to ten tons to the acre. Poultry manure, largely used by Sebastopol growers, is high in nitrogen content and only from two to three tons is used to the acre. Applications are generally made during the dormant season. In fertilizing mature trees, it is advisable to scatter the manure well in between the rows rather than immediately adjacent to the tree trunk.

Cover Crops.—With the scarcity of animal manures the growing of some green crop to plow under, offers the most feasible means of building up the organic matter of the soil. Cover crops not only add this organic matter but the legume crops also add nitrogen.⁷

Owing to the necessity for an adequate supply of water throughout the summer months, cover crops in California have been confined

⁷ Kennedy, P. B., Leguminous plants as organic fertilizers in California agriculture. California Agr. Exp. Sta. Circ. 255:1-8. 1922.

largely to those grown during the fall and winter months. Where the legume crops fail to make a satisfactory growth during this period grains may be sown with the legumes, or if the former make no growth the cereals may be grown alone. As a rule the earlier in the fall a cover crop is sown, the greater will be its benefits.

Among the leading legume crops grown in California are the common vetch (*Vicia sativa*), purple vetch (*Vicia atropurpurea*), bitter clover (*Melilotus indica*), Canada field peas (*Pisum arvense*), bur clover (*Medicago hispida*), and horse bean (*Vicia faba*). As cover crops in apple orchards, the vetches and clovers are as a rule the most widely grown. Vetch is recommended in the coast counties and south of the Tehachapi. Bur clover does well in most parts of the state, usually reseeding itself year after year if soil fertility is maintained. As a rule, however, it fails to produce as heavy a growth as the vetches or bitter clover.

Where one has unlimited irrigation facilities and a soil sufficiently rich in available nitrogen to grow two crops simultaneously, summer crops such as cowpeas, soybeans, sweet clover and its variety, Hubam clover, are sometimes grown. Red clover also seems adapted to the foothills of the Sacramento Valley and may become of considerable importance in the northwestern coast counties. Alfalfa is a permanent crop now almost universally used in the irrigated apple sections of Washington and Oregon and is grown to a limited extent in this state.

In order that a good growth can be obtained before the end of the growing season, cover crops may be sown in irrigated sections in August. In non-irrigated sections, little if any advantage is gained by seeding the crop previous to the beginning of the fall rains. Drilling in the seed is to be preferred to broadcasting, as the depth of the planting can be regulated and a more even stand secured. Although they may vary slightly in different sections, the following rates of seeding are recommended: Field peas, per acre, 60–80 pounds; vetch and horse beans, 40–50 pounds; Melilotus, 25 pounds, or if scarified, 15 pounds; bur clover and cereals (where planted with legumes), 20 pounds. Cereals planted alone, 50–60 pounds.

Unless the nodule bacteria are already present in the soil, inoculation may be necessary for the successful growth of legumes. An adequate amount of lime is also considered essential to the best growth of legume crops. In the Sebastopol section the application of poultry manure seems to be advantageous in securing a good growth of bur clover.

Turning under the cover crop should be delayed as long as possible and yet maintain good soil moisture. Where irrigation is not available the land should be plowed early and worked down in good condition. This will often permit of little spring growth of the cover crop, but delay in this case of even ten days or two weeks may result in a very appreciable loss of soil moisture.

With a supply of irrigation water, the crop can both be started earlier in the fall and allowed to grow later in the spring. The greater the growth made by the crop and the more nearly it can be allowed to approach maturity the greater will be the amount of organic matter derived from it. Cover crops should produce from ten to thirty tons of green material per acre. Legume crops may contain from ten to thirteen pounds of nitrogen per ton of material. Little if any beneficial effects are usually evident from the use of either manures or cover crops until the second season.

Commercial Fertilizers.—Commercial fertilizers at present have a very limited use in apple orchards and they are suggested only where trees are not making satisfactory growth and either animal or green manures cannot be used. The nitrogenous fertilizers such as nitrate of soda and ammonium sulphate have given best results. Being readily soluble and quick in their action they should be applied only early in the spring. It is best to scatter the material over the surface of the soil, under the branches of the tree, and work it in just previous to the opening of the blossoms. The usual rate of application is from one to three pounds for trees one to eight years of age and from four to six pounds for bearing trees. Any results obtained from these fertilizers should be evident during the season immediately following their application.

INTERCROPPING

From five to eight years must elapse after planting an orchard before a commercial crop can be expected. During this unproductive period it is necessary for most growers to secure some returns from the land. Intercropping is a possible source of income. This practice, however, after the first two or three seasons becomes in reality double cropping, in that soil fertility and moisture removed by the intercrop is, in some instances, needed for the best growth of the trees. The fact should not be lost sight of that the trees are the main crop and if they have to compete with some other crop for moisture and plant food elements, they cannot make their most rapid or satisfactory

development. As a rule, therefore, intercrops are most successful on soils of good fertility and on land under irrigation. During the first year after setting the orchard, crops should not be planted closer to the tree rows than six feet and this distance should be increased slightly each year until the intercrop is discontinued.

Cultivated crops are recommended for young orchards and annual crops are considered somewhat more desirable than perennial crops. Among the most desirable crops, where a market is established, are beans, squash, melons, cabbage, turnips, mangels, potatoes, spinach, beets, peas, tomatoes, and rhubarb. Strawberries and the bush fruits rank second and in some instances have been extensively grown. Nursery stock, corn and other grains compete with the trees to a greater extent than other crops and their growth is to be discouraged.

IRRIGATION

Where bearing trees will produce eight to ten inches of new wood growth each year and a satisfactory annual crop of good-sized fruit, irrigation would seem unnecessary. If, however, wood growth is scanty, the fruit even when properly thinned, fails to size properly and is of poor quality, lacking in crispness and flavor, irrigation should be considered. It is believed that the future success of many orchards will depend to a great degree upon whether the owner can supply water during the growing season.

The advantages and some of the factors influencing the need of irrigation have already been mentioned under the general requirements of the apple. A supply of available moisture throughout the growing season is the condition desired and frequent examination of the soil with a soil auger is the most satisfactory method of determining the necessity for, and the frequency of supplying water.

Sufficient amounts of water should be applied to secure thrifty, but not excessive or rank wood growth. Soils which are light and sandy in nature or those underlaid with a substratum of gravel may require frequent applications of water, while on the heavier clay loams the trees may do well with but one or two waterings. In the Yucaipa district, water is applied every fourteen days during the summer to the trees on the lighter soils and every twenty-eight days to those on the heavier soils. From four to eight applications are given each year, allowing the water to run from twelve to seventy-two hours. In other sections of San Bernardino County where the soil is extremely sandy, water is applied every week after June 15. One to

two irrigations in July and August are considered sufficient in the Paradise section, whereas the Watsonville and Sebastopol sections depend entirely upon local rainfall.

Where cover crops are grown it is generally desirable, in the absence of rain after plowing them under, to give the first irrigation soon after this plowing. This will aid in the decay of the cover crop and prevent the surface soil from becoming dried out to the depth



Fig. 4.—Furrow methods of irrigation on light soils in San Bernardino County.

at which it was turned. With apples, the next year's fruit buds are being formed and the current season's crop maturing during the same months, primarily July to September. This period is therefore a critical time for the tree.

The most common method of applying water to apple orchards is the furrow system, where six to eight large furrows six inches or more in depth are made between each two rows of trees. The basin system of flooding may also be used on comparatively level land, while the contour system is best adapted to foothill and mountain sections. Type of soil, topography of the land, the amount of water available and its cost will determine the most satisfactory means of application. The chief essential, however, in applying water is to secure even distribution and good penetration.

PRUNING⁸

TRAINING AND PRUNING YOUNG TREES

Young trees are usually trained to one of three systems, the open center or vase-shaped tree, the central leader type, or the modified leader sometimes called delayed open center type. With the open center system of training, which is the most popular in California, three to five branches are chosen to form the framework of the tree. All of these are so pruned as to maintain as nearly as possible an equal size. Any tendency of a branch to outgrow the others and assume the lead is suppressed. The advantages attributed to this system of training are that it forms an open, spreading, low-headed tree, producing highly colored fruits. The principal objection or disadvantage is that the scaffold branches have a tendency to issue from one point and thus produce a tree structurally weak (fig. 6).

In developing a central leader tree, the upper or topmost branch is allowed the ascendancy and becomes the main leader. Large, strong pyramid-shaped trees are obtained. It is difficult, however, to keep the tree low headed and open, hence this system, largely used in the eastern states, is not recommended for western sections.

The modified leader or delayed open center tree is, as the name would indicate, the result of an intermediate system of training between those just mentioned. The tree is started the same as the central leader type, but after several seasons' growth the leader is cut back and suppressed. Allowing the topmost branch to assume the lead for a period of from two to five years enables one to obtain greater spacing of the scaffolds on the trunk, to secure strong crotches and at the same time keep the tree relatively close to the ground. It is believed that this type of tree has much in its favor and that it should be grown to a greater extent.

Starting the Main Branches.—The height of the tree trunk is determined when first headed. The main stem should be left of sufficient height that approximately six inches will intervene between the main scaffolds and yet not have the lowest branch too near the ground. A height of from twenty-four to thirty inches is recommended. Three main branches well distributed around the trunk as

⁸ For greater details than are given here see: Tufts, W. P., Pruning young deciduous fruit trees. California Agr. Exp. Sta. Bul. 313:113-153. 1919; and Tufts, W. P., Pruning bearing deciduous fruit trees. California Agr. Exp. Sta. Bul. 386:1-47. 1925.

well as up and down are usually all that is desired, although some growers prefer to start as many as five. Observations on bearing trees show that at five feet from the ground five to seven secondary stems are usually all that the tree is able to carry without crowding. Where young trees are already branched when planted, the side branches suitably located may be shortened only, rather than cut off. All superfluous branches, however, should be removed.



Fig. 5.—Close view of bearing tree showing crowding of main branches. Sucker growth has been cut back to induce fruiting wood.

First Summer's Pinching.—By the latter part of April a number of branches will as a rule have started from the numerous buds on the tree trunk. As soon as these young shoots are three or four inches in length, those desired for the framework of the tree should be chosen and those not needed for this purpose pinched back. Such pinching, if done at this time, results in more vigorous growth of the remaining branches, better shaped trees and the necessity for less cutting at the first winter pruning. The trees should be gone over a second time in about six weeks to suppress any new undesirable growth which may have started after the first pinching.

First Dormant Pruning.—At the first dormant pruning, which in California may be given any time after leaf fall and the beginning

of activity in the spring, the scaffold branches should be headed back fifteen to thirty inches or more from the juncture with the tree trunk. As the primary reason for this heading is to induce more branching, the limbs should be cut at the approximate height at which the secondary branches are desired. If the modified leader type of tree is desired, head back the uppermost branch very lightly. Where the variety naturally makes a spreading growth, it is well to head the branches somewhat severely, cutting to an inside bud. Where the growth is upright and a greater spread of branches is desired cut to an outside bud.

The first dormant pruning is of great importance as the tree is being shaped as it should grow. The severity of pruning will also have a marked effect upon the age at which it will come into bearing.

Second Summer's Pruning.—From the main scaffold branches chosen and headed back at the first dormant pruning, numerous shoots are likely to start. Some of these, if not suppressed may outgrow those desired for secondary branches. The tree may also become so filled with new wood that severe thinning will be necessary the following winter. For these reasons it is considered desirable to go over the trees early in the season when the new shoots have attained a length of six to ten inches and remove all undesirable growth. Where it was possible to secure the desired number of well-spaced scaffold branches at the last pruning, two shoots from each of these are sufficient to leave. Where even distribution was not obtained one or more additional shoots well placed may serve to fill a vacancy and produce a better balanced tree.

Second Dormant Pruning.—Where the trees are summer pruned as outlined above, the second dormant pruning should, in most instances, consist only of thinning out superfluous, interfering and misplaced branches. A variety such as Spitzenburg (fig. 7) may necessitate heading of the secondary branches in order to induce further branching at the desired height, but with most varieties this is not necessary and its practice means additional pruning later on and subsequent delay in the time required for the tree to reach commercial production. Any extra long or over-vigorous branch growing at the expense of the others or causing the tree to become unbalanced should be subdued by heading. Heavy or severe cutting will check the growth of any branch, while light pruning or none at all will encourage most rapid development.

Third Summer's Pruning.—Whether summer pruning should continue after the second summer will depend upon the amount of new wood produced and the formation of fruit spurs. Where growth is

exceedingly vigorous and there is no indication of fruiting spurs in the lower portions of the tree, some additional thinning to secure more light may prove advantageous.



Fig. 6.—Four-year-old Red Astrachan tree after pruning. Branches thinned only. Poor crotch in tree due to too low heading and poor training the first year.

Third and Fourth Dormant Pruning.—Pruning during the third and fourth years is largely a continuation of that given the second year. Continue to thin out unnecessary and interfering branches, water-sprout growth and perhaps some small branches near the ground which hinder cultivation. Keep the center of the tree open to

sunlight yet avoid pruning the limbs up “clean” by removing all of the short branches which naturally should develop into fruiting wood. With the modified leader type of tree, the branch which up to this time has been permitted to maintain the ascendancy, is cut back to a lateral and allowed to develop no faster than the others.



Fig. 7.—Five-year-old Spitzenburg tree showing long, rangy growth of branches. Note excellent set of fruit spurs.

PRUNING BEARING TREES

Where trees have been properly cared for during their formative period they should possess good shape and be mechanically able to support heavy loads of fruit. Although some varieties, such as the Rome Beauty, Jonathan, and Wagener, produce a considerable proportion of their fruit on the tips of last year's branches and it is not uncommon for a number of varieties on the Pacific coast to produce fruit laterally on one year twigs, the great bulk of the crop is produced terminally on short branches or spurs originating from wood two years old or older. These spurs normally begin to form after three to five years, or at the time when the young tree naturally shows some tendency to slow up its vegetative growth.

The primary consideration, therefore, in pruning bearing trees is to maintain a proper balance between vegetative growth and fruit

production. Excessive growth such as is made by the young tree is usually produced at the expense of fruit production, while over-bearing is accompanied by less growth and if continued is apt to result in a general lack of vigor. The ideal condition during the years of maturity is where the trees make from six to ten inches of new growth each year, thus increasing and maintaining the fruiting area while at the same time producing large but not excessive annual crops.

With most varieties which previously have received regular pruning, there is little necessity for any pruning other than a light annual thinning. The center of the tree should be kept fairly open. If the trees are attaining too great a height they may be lowered by cutting back some of the larger upright branches to strong laterals. Light crops of fruit and a large amount of vegetative growth would indicate that previous pruning practices had been too severe. Such trees should receive very little dormant pruning. Less cultivation or less water will also help to correct this condition.

PRUNING OLD TREES

Old bearing trees, producing heavy crops of small-sized fruit or those not making six to eight inches of new wood growth annually, require somewhat heavier pruning than younger trees in order to secure the desirable amount of new growth and to maintain the vigor of the fruiting spurs. Moderately heavy thinning of the smaller branches will also reduce the amount of fruit thinning necessary in years of heavy production.

TREATMENT OF PRUNING WOUNDS

Whenever necessary to remove limbs from the tree which are larger than an inch and a half or two inches in diameter, the pruning wounds should be covered with some protective covering in order to prevent the entrance of rot causing fungi. Asphaltum (Grade D), Oronite, a similar preparation which requires no heating, or white lead and raw linseed oil may be used for this purpose. In coastal sections, where the climate favors the growth of these fungi it is desirable, before putting on the coating to disinfect the pruning cuts with corrosive sublimate, 1 part to 1000 parts of water. The chief disadvantage of any wound covering thus far used has been that it requires renewing once or more each season. Recently the Oregon Experiment Station has recommended Bordeaux paint, a covering made by mixing to the consistency of paint, raw linseed oil and

Bordeaux powder. The advantages claimed for the mixture are that it is cheap, non-injurious to the growing layer or cambium, possesses fungicidal value, and is permanent for at least a period of four years. It would seem, therefore, that it might largely, if not entirely replace the materials previously used.

THINNING

While the necessity for thinning the fruit has not been realized to the same extent as that of pruning or spraying, its benefits in years of heavy crop yields are quite apparent and in most commercial orchards thinning is now an established practice. Removing the surplus specimens aids in increasing the size, color, quality, and uniformity of the fruit, prevents breaking of limbs, assists in maintaining the general vigor of the trees, makes possible more effective spraying, and decreases the labor of handling the crop at harvest time.

No definite dates can be given for thinning since it varies with the variety, season, and general climatic conditions. In most instances, however, there is a natural drop of young fruits several weeks after the blooming period. Immediately following this, while the apples are still small and before the seeds develop to any extent is the most accepted time for removing the surplus fruits. With summer apples, however, such as the Gravenstein, the growers of Sonoma County delay thinning until the fruit becomes of sufficient marketable size for culinary uses.

In general, thinning should be practiced to the extent necessary to produce at least moderate size fruit and relieve the overburdened trees. A sufficient number of specimens should be removed so that when the fruits attain their full size they shall be from four to six inches apart on the branch. Unless the set of fruit is very uneven, clusters should be thinned so that only one apple remains in each.

DISEASES OF APPLES AND THEIR CONTROL⁹

Diseases of fruit trees are classified as fungous diseases, caused by the growth of fungi and usually controlled by spraying; bacterial diseases, the result of bacterial growth in the tissues and controllable only indirectly by spraying; and physiological diseases or those produced by some functional disorder which cannot always be definitely determined.

⁹ Horne, W. T., E. O. Essig, and W. B. Herms, Plant diseases and pest control. California Agr. Exp. Sta. Cir. 265:1-124. 1925.

Apple Scab, *Venturia inequalis* (Cke.) Wint. = *Fusicladium*.—Scab is one of the most common and serious diseases. It is usually much worse in sections where high humidity and cool temperatures prevail during the blossoming period. However, the Watsonville district, where these conditions exist, is little troubled with apple scab.

Scab affects the blossoms, fruit, leaves, and occasionally the twigs. It reduces or may destroy the set of fruit, lessens its size and keeping quality, and seriously affects its market value.

The disease is most conspicuous on the fruit, where it first appears as grayish-green spots. The outer skin or cuticle breaks and exposes the olive green spots, which soon become black. As the spots enlarge, the central portion assumes more of a russeted appearance. Infected areas may run together and practically cover an entire side or end of the fruit. Growth is checked on these parts and misshapen fruits result.

Unless rains are frequent or fogs prevail much of the time during and immediately following the blossoming period, the disease may be controlled by spraying with either Bordeaux mixture 4-5-50 (4 lbs. copper sulfate, 5 lbs. fresh quick lime to 50 gals. water) or lime sulfur 1 to 20 (1 gallon of concentrated lime sulfur to 20 gallons of water) as the fruit cluster buds are opening, followed by lime sulfur, 1-35, as the petals are falling. Later applications of Bordeaux may cause russetting of the fruit.

Mildew, *Sphaerotheca leucotricha* (E. & E.) Salm. and *S. oxycanthae* (De C.) De B.—Mildew is another disease that is most prevalent in humid sections and is of chief importance in the Pajaro Valley. A white powdery growth covers the leaves and tips of young shoots, causing them to stop their growth. The leaves may drop prematurely, and if the disease is abundant and allowed to go unchecked the tree may be materially weakened.

Control measures consist of pruning out the infected twigs in winter and spraying in spring with lime sulfur as for scab. When scab sprays are unnecessary 5-10 pounds of wettable sulfur may be added to each 100 gallons of the codling moth spray. In bad cases of infestation the first spraying should be given in the cluster bud stage, followed by additional applications at intervals of three weeks.

Root Rot, *Armillaria mellea* (Vah) Quel.—Root rot, often spoken of as oak root fungus, is found on many of the fruits grown in this state. Trees which are attacked gradually weaken and die, most generally in midsummer. The presence of the disease can be determined by cutting into the affected bark on the roots and lower portion

of the tree, where will be found the white, fan-shaped threads (mycelium) between the bark and the wood. The fungus spreads from old oak and other infected roots and the only recommendation of value is to dig a trench three or four feet deep around the area infected. This will cut the tree roots and prevent spreading to other trees. Reopening of this trench will be necessary every two or three years.¹⁰

Crown Gall, *Bacterium tumefaciens* S. & T.—Crown gall, also known as “root knot” and “hairy root,” causes most serious damage in nurseries but also attacks older trees, forming rounded fleshy tumors on the roots and around the crown. It is also occasionally seen on the branches. Early Harvest, Wealthy, Ben Davis, Grimes, and Rome Beauty are reported as being more susceptible than most other varieties. Trees infected with crown gall, although slightly less thrifty than others, may live many years, but seldom produce full crops of fruit.

No very satisfactory control measures are known. When the disease is discovered before too far advanced, fairly satisfactory results may be obtained by cutting or chiseling out the gall, removing all abnormal tissue to healthy bark and sound wood and disinfecting the wound with mercuric chloride and mercuric cyanide, 1 part of each to 500 parts of water. Cover all wounds with Bordeaux paste or asphaltum. The roots should be examined a second time after a few weeks for the purpose of treating any new galls which may have started.

Blight, *Bacillus amylovorus* (Burr) DeT.—Blight, which is the most destructive disease of the pear, may also attack the apple. The disease attacks the wood, leaves, flowers and sometimes even the fruit. The leaves or flowers blacken and quickly die.

Inasmuch as the blight bacteria work entirely within the tissues of the tree, surgical methods the same as recommended for pear blight are the only means of control.

Little Leaf, Mottled Leaf, Rosette.—These diseases, the exact cause of which is unknown, manifest themselves by a stunted, weak growth of the twigs and foliage. The leaves also generally present a yellowish appearance rather than a rich, green color.

The most promising methods of treatment are increasing the organic matter of the soil, breaking up all hardpan or plow-sole, and sufficient irrigation to insure the maintenance of a proper moisture condition of the soil to a depth of several feet. The planting of

¹⁰ Hendrickson, A. H., Oak fungus in orchard trees. California Agr. Exp. Sta. Cir. 289:1-13. 1925.

alfalfa in orchards where the trees show these diseases appears to have been very beneficial. The soil should also be examined for alkali or other injurious substances.

Bitter-pit, Drought-spot, Cork.—The spotting caused by these diseases is noticed primarily in storage, although they have their beginning earlier. The surface of the fruit shows sunken areas not dissimilar from dents or bruises. Later there is a browning of the pulp cells immediately beneath such areas and often throughout the deeper lying portions of the pulp. The trouble seems to be influenced somewhat by the time of picking the fruit, but perhaps more largely by an uneven distribution of the water supply in the soil and other unfavorable growing conditions. Heavy irrigation seems to increase bitter-pit, while drought-spot and cork appear to be the effect of drought.¹¹

Jonathan-spot, Scald, Internal Browning.—These diseases are likewise primarily storage troubles, although the former may often be noticed before picking the fruit. Jonathan-spot is first seen as circular, rather superficial, brown or almost black, slightly depressed spots. This trouble is especially noticeable on the Jonathan but it also occurs on many other varieties, particularly Spitzenburg, Rome Beauty, and Grimes. The trouble is more severe on fruit of high color. Earlier picking will reduce the severity of the disease.

Apple scald is a term given to a superficial, rather extended browning that involves the color-bearing tissue of the skin, but may in more aggravated cases affect the deeper lying cells of the pulp. In extreme cases the flesh may become soft, brown and rot-like, and is then known as "deep" or "soft scald" in contrast to the more firm "hard scald."

Recent investigations have shown that wrappers impregnated with various mineral oils materially reduce the disease.¹²

Certain varieties of apples, particularly the Yellow Newtown produced in the Pajaro Valley, are subject to an internal browning of the flesh when placed in ordinary cold storage temperatures. A number of factors seem to be associated with this trouble such as cool, moist, growing conditions, rich soil, and general nutritive conditions of the tree. The trouble develops less in storage when the fruit is held at 36°–38° F rather than at 32° F.¹³

¹¹ Brooks, Charles, and D. F. Fisher, Irrigation experiments on apple-spot diseases. *Jour. of Agr. Res.* 12:109–137. 1918.

¹² Brooks, Charles, J. S. Cooley, and D. F. Fisher, Apple scald and its control. U. S. Dept. Agr. *Farmers' Bul.* 1380:1–16. 1923.

¹³ Overholser, E. L., A. J. Winkler, and H. E. Jacob, Factors influencing the development of internal browning of the Yellow Newtown apple. *California Agr. Exp. Sta. Bul.* 370:1–40. 1923.

INSECT PESTS AND THEIR CONTROL

Insect pests have been grouped into those having chewing mouth parts, usually though not always combatted by poison sprays, and those with sucking mouth parts, combatted by contact sprays.

Codling Moth, *Carpocapsa pomonella* Linn.—The codling moth or apple worm is known in practically every section where apples are grown and it is the most destructive apple pest. The tunnels through the flesh and core of the fruit, the pinkish white worm found inside, and the borings about the place of entrance are familiar to all apple growers.

Arsenate of lead, using 2 pounds of powder or 5 pounds of paste to each 100 gallons of water, applied as the petals are falling, again three weeks later, and repeated as often as necessary, has been the standard recommendation for codling moth control.

The fact that arsenical residues made it necessary to wipe much of the fruit during the season of 1926 has led to much discussion as to a possible substitute for this material. However, at the present time leading entomologists consider arsenate of lead as the only known insecticide which is practical and effective. All other possibilities are either ineffective or still in the experimental stage.

Since early spray applications are much more effective in codling moth control and much less objectionable from the standpoint of spray residue than the late applications, it is recommended that special emphasis be placed on the calyx and early cover sprays. If the first brood of the moth is practically eliminated, heavy applications of spray later in the season will be unnecessary.

In addition to spraying, special attention should be given to banding the trees to trap larvae; scraping the bark of rough limbs; thinning the fruit to remove infested specimens; the destruction of windfalls, cull fruit, and waste products; and general orchard and packing house sanitation.

Caterpillars.—Caterpillars, while not often serious, appear in colonies and often defoliate a large branch or part of a tree in a few days' time. Colonies may be controlled by hand picking, spraying as for codling moth, or dusting with powdered arsenate of lead and hydrated lime in equal parts.

Tussock Moths, *Hemerocampa vetusta* (Boisd.).—Occasionally troublesome in some of the coastal sections. Hand picking the white egg masses during the winter months has been followed in the Pajaro Valley.

Fruit Tree Leaf Roller, *Archips argyrospila* Walker.—This insect, usually recognized as a deep green caterpillar about three-quarters of an inch in length, starts feeding early in the season in the opening buds, upon the blossoms, young leaves and fruit. As the foliage grows, the caterpillars draw the leaves together in rolls and tie them with a fine web, thus making hiding places. After this characteristic rolling is noticed sprays are of little value. If noticed earlier spraying with basic arsenate of lead may give partial control. The most satisfactory means of control, however, is by the use of an oil spray during the winter which kills the eggs. These are usually laid in the fall, in small, flat masses, mostly near the end of the new wood. In spraying particular attention should be given, therefore, to thoroughly wet these parts.

Flat-headed Apple Tree Borer, *Chrysobothris mali* Horn.—Since borers rarely attack vigorous, healthy trees the primary method of control is to prevent the trees from becoming weakened. Sunburn, drought, winter injury and injury to the roots all favor and make the tree susceptible to borers. Whitewashing is recommended to prevent sunburn and to repel egg laying. A soap-naphthaline repellent applied early in spring and repeated every three or four weeks is also recommended. Young trees, however, should be watched carefully through the summer for possible attacks of borers and these removed with a knife before they have had time to make extensive tunnels in the bark and wood.

Aphis or Plant Lice.—Green and rosy apple aphid, *Aphis pomi* De Greer, and *Anuraphis roseus* Baker, and the woolly aphid, *Eriosoma lanigera* (Hausm.) are the leading forms of aphid attacking the apple. The first two are easily distinguished on account of their color, and the latter easily recognized by the white or bluish-gray woolly coating. The leaves and shoots infested by aphid are frequently seen to be covered with a black substance as if dusted with soot. This is due to a black fungus which grows on the "honeydew" excreted by the aphid.

There are many successive and overlapping broods of aphid each year. Since aphid puncture through the plant tissues and feed upon the juices, they are combated with the contact sprays. These sprays must be applied early and very thoroughly, especially with the woolly aphid. Late dormant spraying with lime-sulfur gives fair results in killing the eggs. For the root forms of the woolly aphid, it is necessary to first expose the crown of the roots and then wet those and the soil with several gallons of nicotine spray. Refuse tobacco stems may also be buried in the soil or paradichlorobenzene is recommended during the fall.

San Jose Scale, *Aspidiotus perniciosus* Comst.—San Jose scale once an important pest in this state is now a minor trouble, except in neglected orchards. The small, circular, cone-shaped gray scale or covering of the insect and the red or purplish stain on the bark and fruit is well known to most orchardists. Where present, spray with lime-sulfur, 1 to 10, during the winter months.

SPRAY PROGRAM

Fortunately apple growers in any one section do not regularly have to combat all the diseases and insect pests previously mentioned. In some sections certain of these may be almost unknown. On the other hand, one or two of them may be of the greatest importance and may require special control measures. In localities of heavy fogs or repeated rains during the spraying season, from two to six sprayings may be necessary to secure the results equivalent to those of a single spraying under favorable conditions. Differences in climatic conditions and the relative importance of certain diseases and insect pests will therefore cause some variation in spray practices. The relative time of applying the spray, however, and the materials used are rather uniform and hence apple growers generally will follow, in part at least, the following program.

In Late Winter, Before the Buds Begin to Swell.—Commercial lime-sulfur, 1 gallon and water to make 10 gallons, may be used to control San Jose scale, to kill aphid eggs, and to remove moss and lichens. For Italian pear scale use a crude oil emulsion. Black scale and brown apricot scale, which are seldom abundant, may be controlled by distillate emulsions and miscible oils.

In Spring as the Fruit Cluster Buds Open and Before the Petals of the Flowers Show.—For apple scab, lime-sulfur, 1-20, or Bordeaux mixture 4-5-50 (4 pounds bluestone, 5 pounds fresh stone lime, 50 gallons water). If cankerworms or other leaf-eating insects are present, add 6 pounds of *basic* arsenate of lead paste or 3 pounds powder to each 100 gallons of spray used.

As the Petals of the Flowers are Falling.—For scab, apple leaf aphid, and codling moth, spray with lime-sulfur 1-35, one-half pint 40% nicotine sulfate and either 5 pounds *basic* arsenate of lead paste or 2 pounds *basic* arsenate of lead powder to each 100 gallons of spray used. If mildew is present add to the above, 8 pounds of sulfur paste to 100 gallons of spray. In the Watsonville section, where it is not necessary to spray for scab, 3 pounds of powdered arsenate of lead

to each 100 gallons of water is recommended for codling moth. At this time when not mixed with the lime-sulfur the *acid* form of the lead, which is stronger and quicker acting than the *basic* form, may be used.

Twenty to Thirty Days After the Petals Fall.—Repeat the previous spraying, substituting *neutral* or *basic* arsenate of lead for the *acid* form. Where mildew is present use sulfur paste 8 pounds to 100 gallons of water, but no lime-sulfur.

Last Week of July or First Week of August.—If there is a second brood of codling moth in July or early August, indicated by a few wormy apples (first brood of worms) early in July, an additional spraying of arsenate of lead may be necessary. Use 2 pounds dry arsenate of lead to each 100 gallons water. For aphids, spray with 40% nicotine sulfate, one-half pint and 4 pounds of soft soap to each 100 gallons of water or other spray.

As spraying frequently fails to give the anticipated results, it should be emphasized that not only must the proper spray be applied at the right time, but that thoroughness in applying it is necessary. For the most efficient covering, the material should be finely divided and applied at pressures of from 175 to 225 pounds when using a spray rod and 250 to 300 pounds with spray guns. With bad infestations of aphids or where mildew is especially troublesome, special attention should be given to covering the underside of the leaves. Liberal applications of the material should be made early in the season in an effort to avoid repeated sprayings or heavy applications later in the season. Late sprays with arsenicals are particularly undesirable on account of the spray residue on the fruit.

HANDLING NEGLECTED ORCHARDS¹⁴

In most all apple growing sections of the state there are certain orchards which for one reason or another have been more or less neglected. Perhaps this neglect has been due to their unprofitableness and the land might better be devoted to some other crop. On the other hand it is believed there are orchards in good producing districts which, on account of not receiving proper attention, might be made to produce more profitable returns.

Pruning to remove dead, injured or broken branches, to thin out some of the surplus growth in the center of the tree, and to encourage the development of new fruiting wood is usually one of the first

¹⁴ For complete information on this subject see: Gould, H. P., Apple orchard renovation. Farmers' Bul. 1284:1-32. U. S. Dept. Agr. 1922.

operations needed. Often the trees have been so neglected in this respect that several seasons should be taken to remove all the surplus wood. Otherwise excessive vegetative growth may be induced, while the heavy thinning may permit sunburning of the main branches. Trees which have been injured by sunburn, the attacks of borers, or rodents should receive the necessary attention. Broken limbs should be recut and the pruning wounds treated in accordance with previous suggestions.

Following pruning, a thorough winter spraying should be given for moss, lichens or any disease or insect pest wintering on the trees.

Some of the trees may be of unprofitable varieties, and where not too old it may pay to top-graft them over to more desirable sorts. In other instances where the trees are of large size and are badly crowding, the question of removing a part of the trees to allow more light and to facilitate cultivation, spraying and harvesting may require consideration.

With first attention given to the trees, second consideration should be given the soil. Unless on very steep land, good cultivation is desirable. Turning under all vegetative growth, including old leaves and fruit which has been allowed to drop from the trees, will not only increase the organic content of the soil, break the hard soil beneath the surface, and allow better penetration of water, but will assist in eradicating rodents and in reducing insect and disease injury. If the trees have suffered from lack of sufficient soil moisture, supply irrigation water wherever possible. Soils lacking in fertility may be built up by methods already discussed in connection with bearing orchards.

HANDLING THE CROP

It is highly advisable that the grower should be well posted on the subject of picking, handling, packing, and marketing of the crop. Good methods in connection with these practices are necessary if the crop is to reach its destination without losing its attractiveness.

HARVESTING

Time of Harvesting.—The proper time for picking varies widely, depending upon the season, the variety, the location in which the fruit is grown, and the purpose for which it is intended. When the fruit is grown for home use or for local trade, the early varieties especially, may be allowed to remain on the tree until practically ripe enough to eat. Where fruit is to be shipped in commercial

quantities to distant markets, picking is usually in advance of full maturity. With late varieties this is of course necessary on account of climatic conditions.

The exact time at which a commercial crop should be picked is still very largely a matter of individual judgment, and the grower is between the danger of picking too early, with a loss of color and quality on the one hand and that of picking too late, with a general breaking down of the flesh and poor keeping quality on the other. The time elapsing between these two dates is frequently very limited, and the grower is often at a loss to know just when harvesting should begin.

No definite date or single factor has yet been found which is entirely satisfactory for determining best maturity for picking. There are, however, a number of factors which taken together, form a very workable guide. One of these is the ease with which the apple can be removed from the fruit spur. Most varieties when ready for picking, can be broken off from the spur rather easily. With red apples, the color of the fruit is often taken as an indication of their proper maturity. Color, however, may vary rather widely in different districts and in different seasons. Where weather conditions just previous to the time of harvesting are ideal for coloring, the fruit will assume its natural color oftentimes considerably in advance of the proper time for picking. On the other hand, if the weather be cloudy or foggy, the fruit may be well developed and yet show little color. The red or over-color is therefore not an accurate indication of ripeness; a much more accurate index is the green or yellow under-color of the skin. Whenever this color begins to change from a decided green to a slight yellowish green, the fruit may generally be considered in the proper condition for harvesting.

With green varieties loosening from the stem, the color of the seed and the general flavor of the fruit are used in determining proper maturity. Specimens of any variety should be cut and the flesh tested. If quite hard and starchy to the taste the fruit should, in all probability, be allowed to remain on the tree for at least a number of days. It is of course not expected that any variety would possess at this time its characteristic aromatic flavor. The flesh should be decidedly firm and of a sharp acid flavor, but there should be practically no starchy taste.

Recently, considerable data have been secured in connection with the use of a pressure tester as a measure of maturity.¹⁵ Fruit has

¹⁵ Magness, J. R., and Geo. F. Taylor, An improved type of pressure tester for the determination of fruit maturity. U. S. Dept. of Agr. Dept. Cir. 350:1-8. 1925.

been found to begin its process of softening much earlier than has generally been recognized and by the use of the pressure tester one is enabled to secure additional information on the rate of ripening and the probable time fruit may be expected to keep in storage. While its use will never replace other maturity tests it promises to be of value to use in conjunction with them.¹⁶

Methods of Picking and Handling.—There is considerable art in the method of removing apples from the trees. Each specimen should be grasped in the palm of the hand and removed from the fruit spur by a quick upward twist of the wrist. A straight pull will result almost invariably in pulling the stem from the specimen and in tearing the skin in the cavity. Any such break in the skin affords a source of infection for various molds and rots. Tender varieties such as the Winter Banana and the Stayman Winesap must be picked with special care, otherwise they will show the finger marks of the picker, often within a few hours after they are removed from the tree. In the case of varieties which naturally grow in clusters, as the Gravenstein, it is often necessary to use both hands in removing the fruit. When an attempt is made to pick only one or two apples from the cluster, the remaining ones are very likely to drop.

In commercial orchards, the lug boxes are usually distributed ahead of the pickers and stacked between alternate trees in the row. As fast as the boxes are filled they are stacked, usually on the side of the tree protected from the afternoon sun. The pickers should always be warned against filling the boxes so full that when stacked upon one another the fruit will be bruised. Unless the time element is of utmost importance, it is advisable and more satisfactory to pay pickers by the day rather than by the box. Fewer boxes will be harvested but the fruit will show much less bruising and the tree will be left in much better condition for next year's crop. In anticipating the actual quantity of fruit which any picker can harvest in a day's time, consideration must be given to the size and distribution of the crop on the tree, the size of the tree itself, and the general ease with which the fruit can be reached.

If the weather is warm at the time of harvesting, fruit picked in the forenoon should, if possible, be hauled to the packing house before the heat of the day. Fruit picked in the afternoon is often left stacked in the orchard overnight and hauled in the following morning. This practice has the advantage in that the fruit reaches the packing house

¹⁶ Magness, J. R., et al., The ripening, storage and handling of apples. U. S. Dept. of Agr. Dept. Bul. 1406:1-63. 1926.

comparatively cool. Considerable care should be used in loading and unloading from the wagon and when stacking in the packing house. Pitching the boxes, or allowing them to drop for even a distance of a few inches, always bruises some fruit.

PACKING

Community House Packing.—Where one belongs to an association and is conveniently located to either the central or one of the district packing houses, the fruit is usually packed in the association house. Association or community houses have the advantages of modern packing house equipment and can turn out a standardized, uniform pack for the entire district. Such houses are usually arranged to handle the fruit expeditiously and in the most economical manner. Sizing is accomplished by mechanical sizers, to which may be attached wiping machines. Each of the other operations, such as sorting, packing, labeling, and nailing is done by experts. Expert packers working from a grader will easily average 125 to 150 boxes a day, and a few can size the fruit by hand and attain nearly as much speed. The average packer, however, sizing his own fruit, will not turn out over 80 to 100 boxes. Standard size apple boxes are 18 inches in length, 11 inches in width, and 10½ inches in depth, inside measurements, and contain when well packed approximately 48 pounds of apples. The weight varies four to six pounds, according to the variety and tightness of the pack.

Home Packing.—Packing under ranch conditions, where a temporary shed in the orchard or some convenient out-building is used as a packing house, is of necessity slower on account of lack of conveniences and often because of inexperienced help. The grower and his family may do much of the work, packing only a limited number of boxes each day.

Sorting and Sizing.—Regardless of where the fruit is packed, the general principles of the operation are the same. Sorting or grading the fruit for color and defects is the first step in packing. The California Standard Apple Act provides that all apples offered for sale, except those sent to by-products plants, should conform to one of three grades—California Fancy, “B” grade, or “C” grade, and all packers should be familiar with the requirements specified for these grades.¹⁷

¹⁷ A copy of the apple act and rules and regulations governing the packing, inspection, and sale of apples may be obtained from the State Department of Agriculture, Sacramento.

In sorting apples into different grades, there is a natural tendency to have as great a percentage of the fruit as possible in the fancy grade. This grade, however, represents the most nearly perfect apple that can be produced in commercial quantities, and hence the actual percentage of the total crop going into it should usually be small. Each specimen, to rank as first class, must be of *good color, properly matured, of normal shape, and free from insect pests, diseases, bruises and other defects*. While a ten per cent margin in packing is allowed for diseases and insect injuries, yet no grower, sorter, or packer should feel that this is a license to see that the box actually contains its full quota of such specimens. The very reverse attitude should be taken—try to see that every specimen meets the requirements and place every doubtful apple in the next lower grade. It is only in this manner that a reputation for a standard pack of quality can be established and maintained. Specimens lacking in color, slightly limb-rubbed or misshapen, those with one or two healed aphid stings, and those having small scab spots (in the aggregate not exceeding one-fourth of an inch in diameter) but otherwise capable of going into the fancy grade, may be packed in the B grade.

Third or C grade apples include those of poor color and of various shapes. Most specimens also show such defects as slight scab, blossom end cracks, sunburn, frost injury, or skin breaks. The difficulty in packing, the unattractiveness of the package, and the low returns rarely make the operation of packing worth while.

Commercial apple packs commonly found on the market cover a range of from ten to fifteen different sizes, the size in each case being indicated by the number of apples packed in the box. Each size packed varies in its diameter measurements by about one-eighth of an inch. Actual dimensions vary slightly with the different varieties of apples but the average measurement, cheek to cheek diameter, are shown in table 2.

TABLE 2
COMMERCIAL SIZES AND DIAMETER MEASUREMENTS OF APPLES

Size	Inches	Size	Inches	Size	Inches
80	3 $\frac{3}{8}$	125	2 $\frac{7}{8}$	163	2 $\frac{11}{16}$
88	3 $\frac{5}{16}$	138	2 $\frac{13}{16}$	175	2 $\frac{5}{8}$
96	3 $\frac{3}{16}$	150	2 $\frac{3}{4}$	188	2 $\frac{9}{16}$
113	3				

To the amateur, learning to distinguish the different sizes is the most difficult phase of packing. This, however, should largely be mastered before attempting to pack a box of commercial fruit. A measuring board of light wood or heavy cardboard in which a series

of holes are cut is of value in first separating and fixing in mind the different sizes. Sample specimens can then be arranged in rows for frequent comparison. Continued practice for a few days in picking out the various sizes will soon enable one to become sufficiently familiar with them so that they may be recognized at first glance.

Wrapping and Styles of Pack.—Wrapping and placing the specimens in the boxes are illustrated and described in detail in an earlier publication¹⁸ and will be only briefly mentioned. Wrapping is an aid in actually placing the specimens in the box and prevents bruising of the fruit. The actual operation is not difficult to learn, although speed can be acquired only with practice.

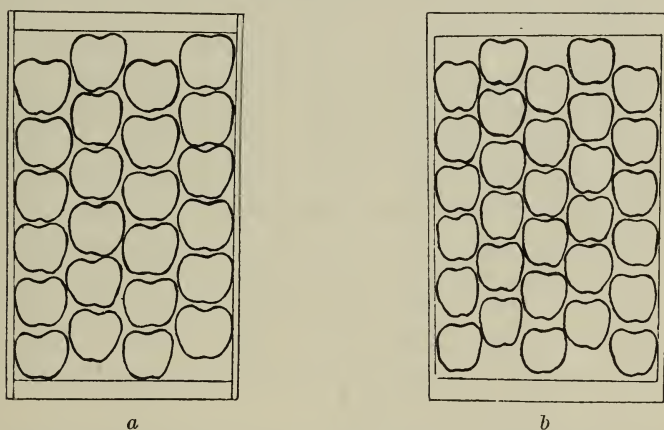


Fig. 8.—Showing the general arrangement of diagonal packs.

a. 2 × 2 pack, 4 layers deep, accommodating sizes 48–96.

b. 2 × 3 pack, 5 layers deep, accommodating sizes 113–188.

The original California apple box and the straight pack is now almost entirely superseded by the northwest box and the diagonal pack. The diagonal arrangement of the apples gives a more solid package, results in less bruising of the fruit and, once learned, is easier to construct. Figure 8 shows the general arrangement of placing the specimens in the first layer of the diagonal packs. In packing the subsequent layers, the apples are placed in the pockets formed by the layer beneath. Sizes between 48 and 96 to the box are packed according to 8a, while those 113 and smaller are packed as illustrated in 8b. Differences between the number of apples in each row lengthwise of the box and the number of layers in the box accommodate the variation in sizes.

¹⁸ Tufts, W. P., The packing of apples in California. California Agr. Exp. Sta. Cir. 178:1–31. 1919.

DRYING¹⁹

Drying furnishes an important outlet for that portion of the crop which on account of the low quality, poor market demand, or inadequate transportation facilities, cannot successfully be sold as fresh fruit. Some 8000 tons of apples are thus utilized annually in California. Santa Cruz and Sonoma counties are the main centers of production, the output comprising that of both commercial dehydrating plants and home evaporators.

Apples intended for drying should be mature but not soft. For a high quality dried product they should also be handled in a manner similar to that portion of the crop which is to be packed as fresh fruit.

Peeling, coring, and slicing of the fruit is usually done by machinery devised for these special purposes. The fruit may or may not be sulfured to prevent darkening. Dropping the individual apples into water immediately after peeling will largely prevent darkening; however, the bleached product is generally preferable on the market. Bleaching is accomplished by exposing the fruit, either before or after slicing, to the fumes of burning sulfur. Sulfuring should continue only long enough to prevent discoloration of the fruit after it is exposed to the air. When the fruit has been previously sliced, sulfuring is more rapid than otherwise. When three or four pounds of sulfur are used per ton of fruit twenty to forty minutes in a tight sulfur chamber is usually sufficient.

Drying temperatures vary slightly, the prevailing practice being to start at approximately 130° F and gradually increasing the temperature up to 175° F, again allowing it to drop slightly as the fruit approaches dryness.

Drying is considered complete when a handful of slices gripped firmly in the hand has an elastic, springy feel and separates immediately when the pressure is released. Legal regulations require that evaporated apples shall not contain more than 24 per cent moisture. Where the fruit is dried in shallow layers on trays a period of from five to eight hours is required for the process.

The quality of the product produced not only depends upon proper methods in handling, but to a large extent upon the variety of apples used. In California the Bellflower and Yellow Newtown are used in greatest quantity. Fall and winter varieties of good cooking quality are preferable to summer varieties or those having decidedly yellow flesh.

¹⁹ For further details of drying see: Caldwell, Joseph F., Farm and home drying of fruits and vegetables. U. S. Dept. Agr. Farmers' Bul. 984:1-37. 1919; and Evaporation of fruits. U. S. Dept. Bul. 1141:1-62. 1923, same author.

MARKETING

MARKETS AND SEASONS

Early summer varieties of apples and others picked green for cooking purposes move to market in June. In July, with the beginning of the Gravenstein season, the shipments increase to 400 or 500 cars. These continue to increase several hundred cars each month until October, when 1000 to 1500 cars, primarily Yellow Bellflower and Yellow Newtown, are marketed. Shipments of the latter variety, as well as other standard winter sorts, hold up well into November. After this time there is a marked decrease in shipments, all fruit necessarily coming from storage.

California Gravensteins ripening early and usually of excellent quality, find a wide market. Approximately 90 per cent of the cars shipped either go to the eastern or central markets or are exported to South America and other countries. Later varieties meeting more competition from other states, find their best market within the state. A small percentage of the supply, however, goes to the southern and central markets, while the smaller sizes of the Yellow Newtown variety fill a demand of the English trade.

TYPES OF SALES

Growers of apples market their fruit either by personal sales or through various marketing agencies. Personal sales may include those where the grower deals directly with local dealers or consumers; F.O.B. sales to cash buyers or representatives of marketing organizations, and orchard sales made to such buyers who may estimate the crop and offer a lump sum for the fruit on the trees.

Selling on local markets, especially those near large cities, is often profitable. Usually, however, the quantity of any product which can be used at a satisfactory price is quite limited. For larger quantities of fruit the F.O.B. type of sale is very desirable. A definite price is agreed upon for a certain quantity of fruit of a recognized grade and the grower may receive cash upon delivery of his product. Buyers of this type, however, are usually scarce except in years of short crops. Estimating the crop, often several months before harvesting, and being offered a definite sum for it on the trees often appears to the grower a safe and easy method of solving the marketing problem. While this method is not without its advantages, the risk assumed by the buyer is such that he is justified in making only a relatively low

offer; pickers whom he may employ to harvest the crop on a box basis often do considerable damage to fruit spurs and limbs of the tree, and finally the grading and packing of the fruit by such buyers is not always such as to advance the reputation of the district for a high quality product.

Personal sales on general markets, usually several hundred miles or more distant, can be recommended only for those who have a wide knowledge of market conditions or who can establish satisfactory market connections. Marketing by consignment leaves everything to the judgment and integrity of the dealer and allows much room for misunderstanding and dissatisfaction.

On account of such large quantities of fruit to be sold within a comparatively short time, the particular preferences of certain markets, the great distance of California from the eastern centers of consumption, and many other factors, successful marketing is becoming more and more a task for marketing specialists or those who can familiarize themselves with market conditions and the general demands of the trade.

As a result the larger quantity of fruit is sold through private marketing agencies or through cooperative marketing associations. The former may purchase the fruit outright or sell on a commission basis. If dealing with a reliable firm this furnishes one of the most satisfactory means of marketing.

Cooperatively owned marketing associations cannot "eliminate the middleman" or guarantee to the growers—who are the owners—larger returns than what they might secure through sales to private agencies but they have a number of possibilities for making marketing more successful.²⁰ Many of these operate their own central packing houses and are thus able to put out a high grade standardized pack which has or will become favorably known on the market. One or more small associations are now operated in most every apple section of the state. Some of these do their own marketing while others sell through state associations such as the California Fruit Exchange or the Deciduous Fruit Distributors.

Growers should realize, however, that as consumers become more critical and compare fruit from California with that from other states that only a superior product will pay suitable returns on their investments. Growers are, therefore, wise to ship to distant markets only a high grade, well standardized, and well packed product.

²⁰ Erdman, H. E., Possibilities and limitations of cooperative marketing. California Agr. Exp. Sta. Cir. 298:1-19. 1925.

STORAGE

As all fall and winter varieties of apples must be harvested within a few weeks, although used throughout the winter months, much of the crop is handled for a period through storage. For the most part, commercial cold storage plants are used. A low temperature and high humidity is maintained in the storage room in order to keep the fruit in good condition throughout its natural holding period. Although the seasonal dates given under each of the winter varieties do not indicate the latest date the fruit can be held in storage they are intended to show its period of greatest consumption.

In some sections where favorable temperature and humidity conditions exist, individual growers have been and are successful in holding the later and longer-keeping varieties for a considerable period in naturally cooled air storages. Fruit stored in such houses will usually become wilted or overripe sooner than that from cold storage plants, yet the former serve a very useful purpose for relatively short storage periods and are extensively used by the apple growers of the Northwest.²¹

YIELDS AND RETURNS

Differences in soil, climatic conditions, varieties, age of trees and general care given the orchards are factors causing wide variation in yields.

The largest and most uniform yields are doubtless secured in the Pajaro Valley, where the majority of orchards, under good care, produce average yields of from 400 to 450 boxes to the acre. From the better orchards 600 to 800 boxes may be produced. In the Gravenstein section of Sonoma County the general average of the full bearing orchard is estimated at 250 boxes, while the more successful growers may secure 400 to 500 boxes to the acre. In both of these sections individual orchards in certain seasons may give even much higher yields, but these are to be regarded as exceptional.

In other sections of the state individual orchards will doubtless compare favorably with the above figures, although owing to younger trees and in some cases lack of proper care, the general average of an entire district is probably much less. Even in the best producing

²¹ Ramsey, H. J., and S. J. Dennis, Management of common storage houses in the Pacific Northwest. U. S. Dept. Agr. Farmers' Bul. 852:1-23. 1917.

sections there are orchards from which the yields are extremely low and it is only those on the better soils and receiving the best management which can be expected to give satisfactory yields.

Average returns from the apple crop for the years 1919-1925 expressed as "farm value" are given in table 1. Figures of the Sebastopol Apple Growers Union show returns on the fancy grade of Gravensteins for the ten-year period, 1915-1925, to have averaged \$1.90 a box. Windfalls and other fruit not suitable for packing has usually been disposed of at about \$10.00 a ton.

Highly colored and well graded winter varieties from the smaller sections at higher elevations have during the past five years averaged from \$1.50 to \$1.75 a box. In some instances F.O.B. sales have been made at \$2.50 a box.

In the Watsonville section, where most growers sell their unpacked crop to local buyers, returns for the years 1920-1925 have been from \$25.00 to \$35.00 a ton²² for the Yellow Newtowns and from \$20.00 to \$30.00 a ton²³ for Yellow Bellflowers. While on a box basis these prices may not seem to compare favorably with those from other sections, it should be pointed out that these figures are for the crop orchard run and do not involve any packing or selling expenses. The larger average yields secured must also be taken into consideration in determining actual net profit.

In mentioning returns it should be emphasized that while these reflect the general condition of the industry, their significance can only be fully realized by the grower who knows his costs of production. High returns per box do not necessarily mean large profits, as low yields, extra cost for spraying, thinning, or marketing affects profit regardless of price.

²² Approximately 55 boxes to the ton.

²³ Approximately 60 boxes to the ton.

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